

WHAT I CLAIM IS:

1 1. An improved frequency dependent excursion limiter circuit for protecting
2 transducers from mechanical overload, said excursion limiter circuit comprising
3 a summing stage for receiving a input signal,
4 a clamping stage following said summing stage for providing a voltage clamping
5 function which limits the voltage of the input signal passed through said clamping stage to a
6 predetermined maximum voltage substantially independent of frequency, said clamping stage
7 having a clamping stage output,
8 a shaping filter stage following said clamping stage, said shaping filter stage providing
9 a frequency response shaping function based on a predetermined frequency response shaping
10 criteria, and including at least one local feed forward branch filter having a feed forward
11 branch filter output summed with said clamping stage output, and
12 an inter-stage feedback loop for providing feedback from the branch filter of said
13 shaping filter stage to said summing stage for providing an inverse frequency response shaping
14 function at said summing stage.

1 2. The improved frequency dependent excursion limiter circuit of claim 1 wherein said
2 summing stage and said clamping stage are combined in a single stage.

1 3. The improved frequency dependent excursion limiter circuit of claim 2 wherein
2 clamping function at said summing stage is provided by local feedback which is summed with
the feedback from the branch filter of said shaping filter stage.

1 4. The improved frequency dependent excursion limiter circuit of claim 1 wherein the
2 feed forward branch filter of said shaping filter stage is an at least second order filter.

1 5. The improved frequency dependent excursion limiter circuit of claim 1 wherein said
2 shaping filter stage includes more than one local feed forward branch filter each having a feed
3 forward branch filter output summed with said clamping stage output to provide a desired
4 frequency response shaping function, and wherein said inter-stage feedback loop provides
5 feedback from the more than one branch filters of said shaping filter stage to said summing
6 stage for providing an inverse frequency response shaping function at said summing stage.

1 6. The improved frequency dependent excursion limiter circuit of claim 1 within said
2 summing stage, clamping stage, and shaping filter stage are op amp based circuits.

1 7. An improved frequency dependent excursion limiter circuit for protecting
2 transducers from mechanical overload, said excursion limiter circuit comprising
3 a summing stage for receiving a input signal, said summing stage including a clamping
4 circuit for providing a voltage clamping function which limits the voltage of the input signal
5 passed through said summing stage to a predetermined maximum voltage substantially
6 independent of frequency, said summing stage having a summing stage output,
7 a shaping filter stage following said summing stage, said shaping filter stage providing
8 a frequency response shaping function based on a predetermined frequency response shaping
9 criteria, and including at least one local feed forward branch filter having a feed forward
10 branch filter output summed with said summing stage output, and

an inter-stage feedback loop for providing feedback from the branch filter of said shaping filter stage to said summing stage for providing an inverse frequency response shaping function at said summing stage which is the inverse of the frequency response shaping function provided by said shaping filter stage.

8. The improved frequency dependent excursion limiter circuit of claim 7 said summing stage includes a local feedback circuit providing local feedback which is summed with the feedback from the branch filter of said shaping filter stage, and wherein the said clamping circuit is inserted in said local feedback circuit.

9. The improved frequency dependent excursion limiter circuit of claim 8 wherein said clamping circuit is comprised of opposed series connected Zener diodes in said local feedback circuit.

10. The improved frequency dependent excursion limiter circuit of claim 7 wherein the feed forward branch filter of said shaping filter stage is an at least second order filter.

11. The improved frequency dependent excursion limiter circuit of claim 10 wherein said shaping filter stage includes more than one local feed forward branch filter each having a feed forward branch filter output summed with said clamping stage output to provide a desired frequency response shaping function, and wherein said inter-stage feedback loop provides feedback from the more than one branch filters of said shaping filter stage to said summing stage for providing an inverse frequency response shaping function at said summing stage.

1 12. An improved frequency dependent excursion limiter circuit for protecting
2 transducers from mechanical overload, said excursion limiter circuit comprising
3 a summing stage having an summing stage input, a summing stage output, a summing
4 stage summing node, and a voltage clamping circuit for clamping the voltage at the summing
5 stage output at a predetermined clamping voltage level,
6 a shaping filter stage having a shaping filter stage input connected to the output of said
7 summing stage, and further having a shaping filter stage output, a shaping filter stage summing
8 node, and a local feed forward circuit from said shaping filter stage input to said shaping filter
9 stage summing node,
10 said shaping filter stage including at least one branch filter having a branch filter output
11 in the feed forward circuit of said shaping filter stage, said shaping filter stage being designed
12 to provide a frequency response shaping function based on a predetermined frequency response
13 shaping criteria related to the frequency dependent excursion limits of the transducers being
14 protected, and
15 an inter-stage feedback circuit connected from the branch filter output of the branch
16 filter of said shaping filter stage to the input summing node of said summing stage for
17 providing feedback to the summing stage for providing an inverse frequency response shaping
18 function at the summing stage which is the inverse of the frequency response shaping function
19 provided by said shaping filter stage.

1 13. The improved frequency dependent excursion limiter circuit of claim 12 wherein
2 said shaping filter stage includes more than one local feed forward branch filter each having a
3 feed forward branch filter output summed with said summing stage output to provide a desired

4 frequency response shaping function, and wherein said inter-stage feedback loop provides
5 feedback from the more than one branch filters of said shaping filter stage to the input
6 summing node of said summing stage for providing an inverse frequency response shaping
7 function at said summing stage.

1 14. The improved frequency dependent excursion limiter circuit of claim 12 wherein
2 the feed forward branch filter of said shaping filter stage is an at least second order filter.

3 15. The improved frequency dependent excursion limiter circuit of claim 12 wherein
4 said summing stage and shaping filter stage are op amp based circuits.

5 16. An improved frequency dependent excursion limiter circuit for protecting
6 transducers from mechanical overload, said excursion limiter circuit comprising

7 a summing stage having an summing stage input, a summing stage output, and a
8 summing stage summing node,

9 a clamping stage following said summing stage for providing a voltage clamping
10 function which limits the voltage of the input signal passed through said clamping stage to a
11 predetermined maximum voltage substantially independent of frequency, said clamping stage
12 having a clamping stage output,

a shaping filter stage having a shaping filter stage input connected to the output of said
summing stage, and further having a shaping filter stage output, a shaping filter stage summing
node, and a local feed forward circuit from said shaping filter stage input to said shaping filter
stage summing node,

said shaping filter stage including at least one branch filter having a branch filter output in the feed forward circuit of said shaping filter stage, said shaping filter stage being designed to provide a frequency response shaping function based on a predetermined frequency response shaping criteria related to the frequency dependent excursion limits of the transducers being protected, and

an inter-stage feedback circuit connected from the branch filter output of the branch filter of said shaping filter stage to the input summing node of said summing stage for providing feedback to the summing stage for providing an inverse frequency response shaping function at the summing stage which is the inverse of the frequency response shaping function provided by said shaping filter stage.

17. A method for protecting transducers from mechanical overload from a driving signal comprising

providing an input for the driving signal,
clamping the driving signal to a predetermined maximum voltage which is substantially independent of frequency if said driving signal exceeds said predetermined maximum voltage,
after clamping, passing the driving signal through a shaping filter stage which provides a frequency response shaping function based on a predetermined frequency response shaping criteria related to the frequency dependent excursion limits of the transducers being protected from mechanical overload, and

providing feedback from the shaping filter stage to the driving signal input to provide an inverse frequency response shaping function at said input which is the inverse of the frequency response shaping function provided by said shaping filter stage.

1 18. The method of claim 17 wherein signal clamping is provided at said driving signal
2 input.

1 19. The method of claim 17 wherein signal clamping is provided by local feedback at
2 said driving signal input.

1 20. The method of claim 17 wherein said driving signal input and signal clamping are
2 provided in separate stages of a circuit.

1 21. The method of claim 17 wherein said shaping filter stage is includes at least one
2 feed forward branch filter having a branch filter output fed back to the driving signal input.

1 22. The method of claim 21 wherein the feed forward branch filter of said shaping
2 filter stage is an at least second order filter.

1 23. The method of claim 21 wherein said shaping filter stage includes more than one
2 local feed forward branch filter each having a feed forward branch filter output fed back to the
3 driving signal input.